Physics 512 (Fall 2006)

HOMEWORK 2

due 9/12/06

1. Exchange to dipolar energy ratio (20 points)

Estimate the ratio of the exchange and dipolar coupling of two adjustent Fe atoms in metallic Fe. (The exchange constant in Fe can be crudely estimated by setting it equal to $k_B T_c$ where T_c is a Curie temperature. (For Fe, $T_c = 1043$ K).

2. Magnetization near T_c (30 points)

Consider spin 1/2 system that orders ferromagnetically at T_c. Show that in the mean-field approximation **just below** T_c, the saturation magnetization has dominant temperature dependence

$$m \propto \sqrt{T_c - T}$$

3. Bleaney-Bowers model (50 points)

Consider the case of two interacting electrons. Triplet state is separated from the singlet state by an enerdy Δ (see sketch). Show that magnetic susceptibility in this model is

$$\chi = \frac{2Ng^2\mu_B^2}{k_B T\left(3 + e^{\Delta/k_B T}\right)}$$

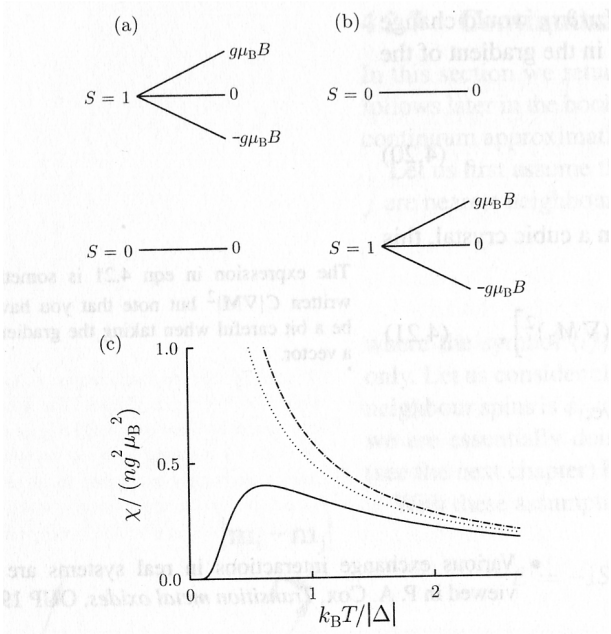

Fig. 4.6 Two spins coupled by Δ give rise to a singlet and triplet state. The energy levels for the case when (a) $\Delta > 0$ and (b) $\Delta < 0$. (c) The susceptibility which is given by the Bleaney–Bowers equation. It is plotted for $\Delta > 0$ (lower curve), $\Delta = 0$ (middle curve), and $\Delta < 0$ (upper curve).